A device particularly useful for comfortably supporting a person includes a hollow member having upper (2) and lower (3) walls joined to each other around their periphery and adapted to be air pressurized. The upper wall is formed with a plurality of openings (12) at spaced locations receiving a plurality of valve members (20) one for each opening (12). Each valve member (20) is normally biased to a closed position with respect to its opening (12), but is engageable by a person supported by the hollow member and is moved thereby to an open position to let air out through its respective opening.
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PERSON SUPPORTING DEVICE

The present invention relates to a supporting device such as a mattress, chair cushion, bedsheet, backrest, etc., for supporting a person in a comfortable manner.

One possible application of the invention is as a mattress for preventing and/or treating bedsores occurring in bedridden patients, particularly elderly or chronically ill persons who are unable to move themselves and who have to lie in the same position for long periods of time. Many devices have been heretofore proposed to prevent or treat bedsores, but the problem has still not yet been solved satisfactorily. Another possible application of the invention is to provide a comfortable seat and/or backrest for a driver or an occupant of an automotive vehicle, aircraft, or the like.

According to the present invention, there is provided a device particularly useful for comfortably supporting a person, comprising a hollow member including upper and lower walls joined to each other around their peripheries and adapted to be connected to air pressurizing means for pressurizing the air in the interior of the hollow member. The upper wall is formed with a plurality of openings thereon at spaced locations. The device further includes a plurality of valve members, one for each of the openings, each valve member being normally biased to a closed position
with respect to its opening, but engageable by a person supported by the hollow member and movable to an open position when so engaged, to thereby let out air from its respective opening between the upper wall and the person.

It will thus be seen that such a supporting device discharges air between the person supported by the device and the upper wall of the device at every point of pressure applied to the upper wall by the person. This discharge of air "softens" the pressure felt by the person at that point. It also circulates air between the device and the occupying person, so that the overall effect is to present a more comfortable feeling to the person. If desired, the air could be cooled or heated. Also, the upper wall may be made of a flexible sheet material so as to produce a pulsating flow of air, and thereby a massaging effect, through each of the openings opened by the movement of a valve member.

According to the further features in the described preferred embodiments of the invention, the openings are circular openings and the valve members are normally biased to engage the edges of the circular openings and to project outwardly through them. The valve members are movable by the person-applied pressure away from the edges of the circular openings, and thereby cause the discharge of air.

In the described preferred embodiments, the valve members are sealed air bubbles formed in a flexible plastic bubble sheet disposed between the upper and lower walls and joined thereto along their outer peripheries to define an upper chamber between the upper wall and the bubble sheet, and a lower chamber between the lower wall and the bubble sheet.
According to still further features in the described preferred embodiments, the upper and lower walls are sheets of flexible plastic material. Such a construction produces a cushioning effect, thereby further contributing to the comfort of the person occupying the device.

Further features and advantages of the invention will be apparent from the description below.

The invention is herein described, by way of example only, with reference to the accompanying drawings, wherein:

Fig. 1 is a top fragmentary view illustrating one form of device constructed in accordance with the present invention;

Fig. 2 is an enlarged longitudinal sectional view illustrating the device of Fig. 1 in its normal condition;

Fig. 3 is a view similar to that of Fig. 2, but illustrating the device in its condition when occupied by a person;

Fig. 4 is a top fragmentary view illustrating another device constructed in accordance with the invention;

Fig. 5 is an enlarged perspective view, more particularly illustrating the structure of the device of Fig. 4;

Figs. 6-10 are longitudinal sectional views illustrating still further constructions in accordance with the present invention;

Fig. 11 is a top fragmentary view illustrating the construction of Fig. 10; and

Figs. 12 and 13 are longitudinal sectional views illustrating still further constructions in accordance with the present invention.
Embodiment of Figs. 1-3

The device illustrated in Figs. 1-3 of the drawings is intended for use as a mattress, bedsheet, or chair cushion, to support a person occupying the device in a comfortable manner. Thus, as best seen in Fig. 2, the device includes a hollow member having an upper wall 2, a lower wall 3, and an intermediate wall 4; all of flexible plastic sheet material. The upper wall 2 and the lower wall 3 are each of single-layered sheets, but intermediate wall 4 is a lamination of two sheets 4a, 4b. All the sheets are joined along their outer peripheries as shown at 5, 6 and 7, 8 in Fig. 2, so as to define an upper chamber between the upper sheet 2 and the intermediate sheet 4, and a lower chamber between the lower sheet 3 and the intermediate wall 4. In addition, the upper sheet 2 and lower sheet 3 are joined to intermediate wall 4 along longitudinal and transverse partition lines, as shown at 9 and 10, respectively, in Fig. 1, thereby dividing the upper chamber into a plurality of upper cells C₁, and the lower chamber into a plurality of lower cells C₂, all of substantially square configuration.

The upper sheet 2 is formed with a plurality of circular openings 12, one located centrally of each of the upper cells C₁. The intermediate laminated wall 4 is a flexible bubble sheet constituted of two sheets 4a, 4b, each embossed with a plurality of semi-spherical cavities 20a, 20b, and laminated together to define a plurality of sealed, spherical air bubbles 20. The upper half of each air bubble 20, defined by the semi-spherical cavity 20a formed in sheet 4a, is aligned with and projects slightly through a circular opening 12 in upper sheet 2. The lower half of each air
bubble 20, defined by the semi-spherical cavity 20b in sheet 4b, is wholly enclosed within the respective lower cell C₂.

Peripheral wall 6 of the lower cells C₂ includes an inlet 21 for inletting pressurized air from a source indicated at PS in Fig. 1. If desired, the opposite end of the device may also include an inlet 22 for inletting pressurized air into the lower cells C₂. The partitions 9 between the lower cells C₂ include small holes 23, establishing communication between the lower cells and thereby equalizing the pressure in all the lower cells.

The laminated bubble sheet 4 is also formed with small holes 24 so as to establish communication between the upper cells C₁ and the lower cells C₂, thereby also tending to equalize the pressure in these two groups of cells.

The device illustrated in Figs. 1-3 operates as follows:

When the inlets 21, 22 are connected to a source of pressurized air, the increase in pressure is transmitted to all the lower cells C₂ via the openings 23 in the partitions 10, so that the pressure in all the lower cells C₂ increases above atmospheric pressure. In addition, the increased pressure in the lower cells C₂ is communicated to the upper cells C₁ by the small holes 24 in the bubble sheet 4.

The positive pressure in the lower cells C₂ is applied over a larger surface of the bubble sheet 4 than the positive pressure in the upper cells C₁, thus biasing the bubble sheet 4 towards the upper sheet 2 to press its bubbles 20 firmly against the inner edges of circular openings 12 in upper sheet 2. Thus, the bubbles 20 act as
valve members normally biased to close the circular openings 12 in upper sheet 2 and thereby to block the discharge of air from upper cells C₁.

When the illustrated device is used as a mattress, bedsheet, chair cushion, or the like, to be occupied by a person, the weight of the person applies pressure to the portions of the bubbles 20 projecting through the circular openings 12 and presses these bubbles inwardly, away from the inner edges of the circular openings 12 in the upper sheet 2. The pressurized air within the upper cells C₁ is thus discharged from each such opening 12. The small holes 24 formed in the bubble sheet 4 replenish the air discharged from the upper cells C₁ with air from the lower cells C₂, at a rate determined by the size of holes 24.

When the person shifts a pressure point from one bubble 20 to another, the bubble relieved of the pressure moves back to close its circular opening 12, whereas the bubble to which the pressure has now been applied moves to open its respective opening 12 and thereby to discharge air at that pressure point. The pressure within the upper cell C₁ at the relieved pressure point then returns to its normal value because of openings 24 in bubble sheet 4, and thus that cell is now available to discharge air the next time pressure is applied to its bubble 20.

The overall effect is to cause a discharge of air at each point of contact between the person and upper wall 2 of the device. This produces a "softer" feeling at these points of contact, and also circulates air between the person and the device at each of said contact points. If desired, this air may be heated in winter or cooled in summer.
Moreover, because of the flexible nature of upper sheet 2, it is believed that a somewhat pulsative flow of the air will be produced through the openings opened by bubbles 20. Thus, as a bubble 20 is moved inwardly away from its respective opening, the air will flow through the opening to produce a lower pressure within the respective upper cell $C_1$; this will draw the edges of the sheet back against the bubble to temporarily interrupt the flow, thereby producing a fluttering effect of the sheet edge with respect to the bubble. Such a pulsative flow of air through the openings will result in a desirable massaging effect at each point of contact of the person's body with upper wall 2.

If desired, the bubble sheet 4 may be produced so as to provide a particularly resilient juncture with the bubble 20, as shown by the folds or corrugations at 30 in Fig. 2, and thereby to permit a larger and easier displacement of the bubble when it is subjected to pressure. In addition, the upper sheet 2 and the portion of the bubbles 20 projecting through its circular openings 12 may be covered by a towel or other porous sheet, as shown by sheet 32 in Fig. 3, to permit the air within the upper cells $C_1$ to be discharged outwardly, even though the occupant's body may physically close some of the circular openings 12 in the upper sheet 2.

**Embodiment of Figs. 4 and 5**

Figs. 4 and 5 illustrate a variation of the invention wherein the bubble sheet, therein designated 104, is formed with a plurality of active bubbles, designated 120 a, and also with a plurality of passive bubbles, designated 120p. The active bubbles 120a project through circular openings 112 in the upper sheet 102 to serve as valve members for controlling the flow of air from the upper cells, in the
same manner as described above with respect to Figs. 1-3. However, upper sheet 102 does not include circular openings aligned with the passive bubbles 120p, so that these passive bubbles merely serve to space the bubble sheet 104 from the upper sheet 102, thereby enhancing the cushioning effect produced by the device.

Embodiment of Fig. 6

Fig. 6 illustrates a further construction, also including two outer sheets 202, 203 similar to sheets 2 and 3 in Figs. 13, but in this case the intermediate wall is made of a bubble sheet consisting of three laminated sheets 204a, 204b and 204c. Sheet 204a is embossed with semi-spherical cavities, but neither of the other two sheets 204b, 204c is so embossed, so that the bubble sheet defines semi-spherical bubbles as shown at 220.

All three layers 204a, 204b, 204c of bubble sheet 204 are bound together along longitudinal and transverse partition lines, as shown at 240, and are provided with passageways through these bonded areas, as shown at 241. In addition, outer sheet 202 is bonded to layers 204a and 204b of the bubble sheet 204 along longitudinal and transverse partition lines, as shown at 242. Further, the lower sheet 203 and the lower layer 204c of the bubble sheet are bonded together along the longitudinal and transverse partition lines shown at 243. Such a construction thus defines three groups of cells, namely, cells Ca between sheets 202 and 204a; cells Cb between sheets 203 and 204c; and cells Cc between sheets 204b and 204c. Communication is established between cells Cb and Cc by openings 244 formed in sheet 204c, and communication is established between cells Cb and Ca by openings 241 formed in the bond lines 240.
The pressurized air is applied to cells Cc and is communicated to cells Cb via holes 244, and to cells Ca via passageways 241.

The structure and operation of the device illustrated in Fig. 6 are otherwise the same as described above with respect to Figs. 1-3.

**Embodiment of Fig. 7**

Fig. 7 illustrates a construction similar to that of Figs. 1-3, including an upper sheet 302, a lower sheet 303 and an intermediate bubble sheet 304. In the construction illustrated in Fig. 7, the bubble sheet 304 is formed with substantially semi-spherical bubbles 320 rather than spherical bubbles, such that the lower portions of the bubble 320 within the lower cells C_2 are spaced from the lower sheet 303 rather than engaging the lower sheet.

Another difference in the construction of Fig. 7 is that the partitions 309 dividing the upper chamber into the upper cells C_1 are formed with small openings 325 in order to establish communication between all the upper cells C_1, and thereby to equalize the pressure in those cells when their bubbles 320 are in the closed position with respect to the openings 312.

The construction illustrated in Fig. 7 also includes openings 323 in partitions 309, establishing communication between the lower cells C_2; and openings 324 in the bubble sheet 304, establishing communication between upper cells C_1 and lower cells C_2. The embodiment of Fig. 7 otherwise operates in substantially the same manner as described above with respect to Figs. 1-3.
Embodiment of Figs. 8 and 9

Fig. 8 illustrates a construction similar to that of Fig. 7, including an upper flexible sheet 402, a lower flexible sheet 403, and intermediate sheet 404 carrying the bubbles 420, which act as valves for opening and closing the openings 412 in upper sheet 402. In this case, however, the bubbles 420 are filled with a spongy elastomeric foam 421 rather than with air. The construction of Fig. 8 is otherwise the same, and operates in substantially the same manner, as that of Fig. 7.

Fig. 9 illustrates another construction including an upper flexible sheet 802, a lower flexible sheet 803, and an intermediate sheet 804 carrying the caps acting as valves for opening and closing openings 812 in the upper sheet 802. In the construction illustrated in this figure, however, the caps acting as valves are hollow and opened from below. Another difference from the embodiments of Figs. 7 and 8 is that the dividing partitions 809 include openings 823 for communication only between the lower cells C2.

Embodiment of Figs. 10 and 11

The embodiment of Figs. 10 and 11 also includes semi-spherical bubbles 520 formed in the intermediate sheet 504 for closing the openings 512 in the upper sheet 502 and spaced from lower sheet 503. Bubbles 520 may be filled with air, as in Fig. 7, or with an elastomeric spongy material, as shown in Fig. 8. In the construction illustrated in Figs. 10 and 11, however, the partitions 509 defining upper cells C1 and C2 are not in the form of continuous weld lines as in Fig. 1, for example, but rather are in the form of spot welds, as shown at 521. Such a construction thus produces passageways between the spot welds, interconnecting
the upper cells \( C_1 \) with each other, and the lower cells \( C_2 \) with each other.

**Embodiment of Figs. 12 and 13**

Fig. 12 illustrates a construction, also including an upper plastic sheet 602, a lower plastic sheet 603, and an intermediate bubble sheet 604. In the construction of Fig. 12, however, the upper plastic sheet 602 is also a bubble sheet and is formed with closed bubbles 602a, engageable with the intermediate bubble sheet 604 for spacing the intermediate bubble sheet from the upper bubble sheet. In addition the lower plastic sheet 603 is also a bubble sheet, being formed with closed bubbles 603a for spacing the intermediate bubble sheet from the lower sheet.

The construction illustrated in Fig. 13 is similar to that of Fig. 12, except that of the upper and lower sheets 702, 703, only the lower sheet 703 is in the form of a bubble sheet, being formed with closed bubbles 703a for spacing it from the intermediate bubble sheet 704.

The constructions illustrated in Figs. 12 and 13 are otherwise substantially the same, and operate in substantially the same manner, as described above.

While the invention has been described with respect to a number of preferred embodiments, it will be appreciated that many other variations may be made. For example, the lower sheet (3 or 203) may be constituted of two laminated films embossed with passageways defining distributor ducts for distributing the pressurized air throughout the lower cells \( C_2 \). In addition, the partitions (e.g., 9 and 10, Figs. 1-3) may define cells of various configurations, e.g., circular, hexagonal, etc., other than the square
configuration illustrated in the drawings. The pressurized air applied to inlets 21, 22 may be from any high pressure source, such as an air pressure line, a blower, or a pressurized air tank.

Many other variations, modifications and applications of the invention will be apparent.
WHAT IS CLAIMED IS:

1. A device particularly useful for comfortably supporting a person, comprising:
   a hollow member including upper and lower walls joined to each other around their peripheries and adapted to be connected to air pressurizing means for pressurizing the air in the interior of said hollow member;
   said upper wall being formed with a plurality of openings thereon, at spaced locations; and
   a plurality of valve members, one for each of said openings, each valve member being normally biased to a closed position with respect to its opening, but engageable by a person supported by said hollow member and movable to an open position when so engaged, to thereby let air out through its respective opening between said upper wall and said person.

2. The device according to claim 1, wherein said openings are circular openings and said valve members are normally biased to engage the edges of said circular openings and to project outwardly therethrough, said valve members being engageable by said person's body and movable away from the edges of said circular openings and thereby to let air out therethrough.

3. The device according to claim 2, wherein said upper wall is a sheet of flexible plastic material.
4. The device according to claim 2, wherein said valve members are sealed air bubbles formed in a flexible plastic intermediate bubble sheet disposed between said upper and lower walls and joined thereto along their outer peripheries, to define an upper chamber between said upper wall and said bubble sheet and a lower chamber between said lower wall and said bubble sheet.

5. The device according to claim 4, further including an inlet to said lower chamber connectible to said air pressurizing means for pressurizing the air therein, said intermediate bubble sheet also including a plurality of small holes establishing communication between said upper and lower chambers, tending to equalize the pressure therein when said sealed air bubbles are in their closed positions with respect to the openings in said upper wall.

6. The device according to claim 4, wherein said intermediate bubble sheet includes two plastic sheets, at least one of which is embossed with a plurality of semi-spherical cavities and laminated together to define a plurality of air bubbles.

7. The device according to claim 6, wherein both of said laminated plastic sheets of the intermediate bubble sheet are embossed with a plurality of semi-spherical cavities, whereby the laminated sheets define a plurality of spherical air bubbles.
8. The device according to claim 7, wherein said air bubbles are normally spaced from the lower wall but are engageable with the lower wall when the air bubbles are moved to their open positions.

9. The device according to claim 6, wherein only one of said plastic sheets is embossed with said plurality of semi-spherical cavities, whereby said laminated plastic sheets define a plurality of semi-spherical air bubbles.

10. The device according to claim 9, wherein said laminated plastic sheets include a third plastic sheet bonded to said non-embossed plastic sheet at discrete locations on the opposite side thereof to said embossed plastic sheet, said discrete bonding locations forming passageways establishing communication between said upper and lower chambers.

11. The device according to claim 3, wherein said lower wall is a sheet of flexible plastic material.

12. The device according to claim 3, wherein said valve members are caps formed in a flexible intermediate plastic sheet disposed between said upper and lower walls and joined thereto to define an upper chamber between the upper wall and the intermediate sheet and a lower chamber between the lower wall and the intermediate sheet.
13. The device according to claim 11, wherein said upper and lower plastic sheets are also joined to said intermediate plastic bubble sheet along a plurality of partition lines, to divide said upper and lower chambers into a plurality of cells.

14. The device according to claim 13, wherein said partitions include openings to equalize the air pressure in the cells of said lower chamber.

15. The device according to claim 13, wherein said partitions include openings to equalize the air pressure in the cells of said upper chamber.

16. The device according to claim 13, wherein said partitions are defined by spot welds between said upper and lower plastic sheets and said intermediate bubble sheet, producing passageways between the spot welds interconnecting said upper cells with each other and said lower cells with each other.

17. The device according to claim 13, wherein said upper plastic sheet is also a bubble sheet, and is formed with closed bubbles engageable with said intermediate bubble sheet.

18. The device according to claim 13, wherein said lower sheet is also a bubble sheet, and is formed with closed bubbles engageable with said intermediate bubble sheet.
19. The device according to claim 4, wherein said bubble sheet is formed with a plurality of active air bubbles, each serving as one of said valve members cooperable with one of said openings in said outer wall, and a plurality of passive air bubbles serving as spacing elements to space said bubble sheet from said outer wall.

20. The device according to claim 1, in combination with air pressurizing means for pressurizing the air in the interior of said hollow member.
# INTERNATIONAL SEARCH REPORT

**A. CLASSIFICATION OF SUBJECT MATTER**
- IPC(6) : A61G 27/08; A61G 7/057

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
- U.S. : 5/469,453,449,455,456,654,423; 297/180.13, 284,6,452,41,452.42

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of Box C. See patent family annex.

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Date of the actual completion of the international search: 28 AUGUST 1995

Date of mailing of the international search report: 15 AUG 1995

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